CLAIMS

1) Transmission method for transmitting a plurality of symbols from a base station of a MC-CDMA telecommunication system to a plurality (K) of users, each symbol (d_k) to be transmitted to a user being spread with a coding sequence ($c_k(\ell)$) over a plurality (L) of carriers (ℓ) to produce a plurality of corresponding frequency components, said base station being provided with a plurality (M) of antenna elements, characterised in that each frequency component produced by a symbol of a user (k) is weighted by a plurality (M) of weighting complex coefficients ($w_k^*(\ell,m),m=1,..,M$) to obtain a plurality (LM) of weighted frequency components ($z_k^m(\ell)$), each weighting coefficient being relative to a user (k), a carrier (ℓ) and an antenna element (m) and said plurality of weighting coefficients being determined from estimates of the channel coefficients ($h_k(\ell,m)$) of the downlink transmission channels between each antenna element and each user for each carrier frequency.

2) Transmission method according to claim 1, characterised in that, for each antenna element (m) the weighted frequency components relative to said antenna element and to the different users are added up per carrier to output a plurality (L) of compound frequency components $\left(\sum_{k=1}^{K} z_k^m(\ell), \ell = 1,..,L \right)$, said plurality of compound frequency components being further subjected to an inverse Fourier transform to generate a signal ($S^m(t)$) to be transmitted by said antenna element.

3) Transmission method according to claim 1 or 2, characterised in that said estimates of the channel coefficients are obtained as estimates of the channel coefficients of the uplink transmission channels between each user and each antenna element for each carrier frequency.

4) Transmission method according to claim 3, characterised in that the weighting coefficients relative to a given user are obtained as a function of the coding sequences of all said users, said estimates of channel coefficients, the transmit powers (Pt_k) used for respectively transmitting said symbols to the different users, a

variance of noise (σ^2) affecting the received frequency components at the user side and equalising coefficients applied thereto.

5) Transmission method according to claim 4 characterised in that the weighting coefficients relative to a given user g are determined from the elements of a vector $\mathbf{w}_g^*$ where $.^*$ denotes the conjugate operation and where $\mathbf{w}_g$ is determined according to an expression of the type:

$$\mathbf{w}_g = \mu_g \left(\hat{\boldsymbol{\Phi}}_g + \sigma^2 . \mathbf{I}_{ML} \right)^{-1} (\tilde{\mathbf{c}}_g^* \circ \tilde{\mathbf{q}}_g \circ \hat{\mathbf{h}}_g \circ \tilde{\mathbf{c}}_g)$$

where, M and L being respectively the number of antenna elements and the number of carriers;

$\tilde{\mathbf{c}}_g$ is a vector of size $M.L$ defined as the concatenation of M times the vector $\mathbf{c}_g = \left(c_g(1), .. , c_g(L) \right)^T$ representing the coding sequence of said given user g ;

$\tilde{\mathbf{q}}_g$ is a vector of size $M.L$ defined as the concatenation of M times the vector $\mathbf{q}_g = \left(q_g(1), .. , q_g(L) \right)^T$ representing the equalising coefficients for said given user g;

$\hat{\mathbf{h}}_g$ is a vector of size $M.L$ the first L elements of which represent the said estimates of the channel between antenna element 1 and user g, the second L elements of which corresponding to the channel between antenna element 2 and user g and so on;

μ_g is a scalar coefficient given by the constraint upon the transmit power for user g;

$\mathbf{I}_{ML}$ is the identity matrix of size $M.L \times M.L$;

σ^2 is the value of said noise variance;

$\hat{\boldsymbol{\Phi}}_g$ is a hermitian matrix characterising the multiple access interference generated by user g on the other users ;

and where $.\circ.$ denotes the element by element multiplication of two vectors.

6) Transmission method according to claim 5 characterised in that said hermitian matrix is obtained from an expression of the type:

$$\hat{\mathbf{\Phi}}_g = \sum_{k \neq g}^{K} Pt_k \cdot \hat{\mathbf{v}}_{kg} \hat{\mathbf{v}}_{kg}^H$$

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where K is number of users, Pt_k is the transmit power for user k and

$$\hat{\mathbf{v}}_{kg} = \tilde{\mathbf{c}}_k^* \circ \tilde{\mathbf{q}}_k \circ \hat{\mathbf{h}}_k \circ \tilde{\mathbf{c}}_g$$

10   where $\tilde{\mathbf{c}}_k$ is a vector of size $M.L$ defined as the concatenation of M times the vector $\mathbf{c}_k = (c_k(1),..,c_k(L))^T$ representing the coding sequence of user k ;

$\tilde{\mathbf{q}}_k$ is a vector of size $M.L$ defined as the concatenation of M times the vector $\mathbf{q}_k = (q_k(1),..,q_k(L))^T$ representing the equalising coefficients for user k.

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$\hat{\mathbf{h}}_k$ is a vector of size $M.L$ the first L elements of which represent the said estimates of the channel between antenna element 1 and user k, the second L elements of which corresponding to the channel between antenna element 2 and user k and so on.

20   7) Transmission method according to claim 4 characterised in that the weighting coefficients relative to a given user g are determined from the elements of a vector $\mathbf{w}_g^*$ where $.^*$ denotes the conjugate operation and where $\mathbf{w}_g$ is determined according to an expression of the type:

25    $$\mathbf{w}_g = \mu_g \left(\hat{\mathbf{\Phi}}_g + \sigma^2 . \mathbf{I}_{ML} \right)^{-1} (\tilde{\mathbf{c}}_g^* \circ \hat{\mathbf{h}}_g \circ \tilde{\mathbf{c}}_g)$$

where, M and L being respectively the number of antenna elements and the number of carriers;

$\tilde{\mathbf{c}}_g$ is a vector of size $M.L$ defined as the concatenation of M times the vector

30    $\mathbf{c}_g = (c_g(1),..,c_g(L))^T$ representing the coding sequence of said given user g ;

$\hat{\mathbf{h}}_g$ is a vector of size $M.L$ the first L elements of which represent the said estimates of the channel between antenna element 1 and user g, the second L elements of which corresponding to the channel between antenna element 2 and user g and so on;

μ_g is a scalar coefficient given by the constraint upon the transmit power for user g;

$\mathbf{I}_{ML}$ is the identity matrix of size $M.LxM.L$;

σ^2 is the value of said noise variance;

$\hat{\mathbf{\Phi}}_g$ is a hermitian matrix characterising the multiple access interference generated by user g on the other users ;

and where $.o.$ denotes the element by element multiplication of two vectors.

8) Transmission method according to claim 4 characterised in that the weighting coefficients relative to a given user g are determined from the elements of a vector $\mathbf{w}_g^*$ where $.^*$ denotes the conjugate operation and where $\mathbf{w}_g$ is determined according to an expression of the type:

$$\mathbf{w}_g = \mu_g \left(\hat{\mathbf{\Phi}}_g + \sigma^2.\mathbf{I}_{ML} \right)^{-1} \hat{\mathbf{h}}_g$$

where, M and L being respectively the number of antenna elements and the number of carriers;

$\hat{\mathbf{h}}_g$ is a vector of size $M.L$ the first L elements of which represent the said estimates of the channel between antenna element 1 and user g, the second L elements of which corresponding to the channel between antenna element 2 and user g and so on;

μ_g is a scalar coefficient given by the constraint upon the transmit power for user g;

$\mathbf{I}_{ML}$ is the identity matrix of size $M.LxM.L$;

σ^2 is the value of said noise variance;

$\hat{\mathbf{\Phi}}_g$ is a hermitian matrix characterising the multiple access interference generated by user g on the other users .

9) Transmission method according to claim 7 or 8, characterised in that said hermitian matrix is obtained from an expression of the type:

$$\hat{\mathbf{\Phi}}_g = \sum_{k \neq g}^{K} Pt_k \cdot \hat{\mathbf{v}}_{kg} \hat{\mathbf{v}}_{kg}^H$$

where K is number of users, Pt_k is the transmit power for user k and

$$\hat{\mathbf{v}}_{kg} = \tilde{\mathbf{c}}_k^* \circ \hat{\mathbf{h}}_k \circ \tilde{\mathbf{c}}_g$$

where $\tilde{\mathbf{c}}_k$ is a vector of size $M.L$ defined as the concatenation of M times the vector $\mathbf{c}_k = (c_k(1), ..., c_k(L))^T$ representing the coding sequence of user k;

$\tilde{\mathbf{c}}_g$ is a vector of size $M.L$ defined as the concatenation of M times the vector $\mathbf{c}_g = (c_g(1), ..., c_g(L))^T$ representing the coding sequence of said given user g ;

$\hat{\mathbf{h}}_k$ is a vector of size $M.L$ the first L elements of which represent the said estimates of the channel between antenna element 1 and user k, the second L elements of which corresponding to the channel between antenna element 2 and user k and so on;

and where $.\circ.$ denotes the element by element multiplication of two vectors.